



ALEXANDRU IOAN CUZA UNIVERSITY FROM IAȘI
GEOGRAPHY AND GEOLOGY FACULTY
GEOSCIENCES DOCTORAL SCHOOL



Summary of the PhD Thesis

CHANGES OF THE HYDRO-MORPHOLOGICAL CONDITIONS OF THE SFÂNTU GHEORGHE ARM AS A RESULT OF THE HYDROTECHNICAL WORKS TO REGULATE THE WATER COURSE

Scientific coordinators:

Prof. Dr. Gheorghe Romanescu

Prof. Dr. Dan Dumitriu

PhD Candidate:
Trifanov Cristian

Geography discipline

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Abstract

The Danube Delta Biosphere Reserve (R.B.D.D.) has an exceptional universal value, having a triple conservation status: (i) biosphere reserve in its entirety, through its inclusion in the world network of biosphere reserves within the UNESCO "Man and the Biosphere" Program in 1990, (ii) wetland area of international importance, especially as a waterfowl habitat, according to the Ramsar Convention (Iran), to which Romania acceded in 1991, and (iii) universal natural heritage area, being included in year 1990 and in the UNESCO World Cultural and Natural Heritage list.

The natural resources of the Danube Delta must be subject to a more effective management throughout their life cycle, from the extraction, transport, processing and consumption, to the management of the resulted waste. This is a general principle applicable to all natural resources, including food, timber, biodiversity, energy, metals, soil, water, minerals, atmosphere and land. Improving the efficiency of resource use in Europe a means by which economic, social and environmental objectives can be achieved more easily, more safely and at lower costs. That is why the European Commission emphasizes the importance of "resource efficiency". Resource efficiency means generating more value using fewer resources and changing consumption habits. This will reduce the risk of deficits and keep the environmental impact within the natural limits of the biosphere.

The establishment of the European Commission of the Danube (CED) in 1856 had a significant impact on the Sulina arm, which was selected following topo-hydrographic measurements carried out in 1857-1858 under the direction of engineer Sir Charles Hartley, to be laid out for river-marine navigation. This event generated important changes in the area of the Danube Delta, focusing especially on the Sulina arm. In order to achieve this objective, works were carried out to regularize some meanders (such as Maliuc and "Marele M" - representing the Old Danube course), which reduced the navigable distance from 83.4 Km to 62.6 Km and deepened the riverbed to a minimum of 7.9 m (24 feet), to allow the navigation of vessels of up to 55,000 tdw.

The first changes in the internal hydrographic network of the Danube Delta, in order to improve fish productivity in a natural environment, were initiated by the hydrobiologist Grigore Antipa. Between 1900 and 1935, on his recommendation, several canals were built to facilitate water circulation between the Danube arms, the lake complexes in the delta area and the Razim - Sinoie Lake Complex.

Starting from 1986, works were initiated to regularize the water course of the Sfântu Gheorghe arm, which involved the "adjustment" of its six meanders. This intervention was necessary to protect the heavily eroded banks, especially in the southern area of the river mouth. However, this adjustment had a major impact on the hydrological and sedimentological balance of the adjacent aquatic complexes. At the same time, these changes had an impact on the sedimentation regime at the mouths of the canals and at the river mouth, on the quality of the reed masses, on the surfaces of the habitats and the landscape quality. This was necessary to support economic activities, but had consequences for the natural functioning of the hydrological system and ecological components of the area.

Therefore, this thesis involves an exhaustive study to evaluate the current situation of the meanders of the Sfântu Gheorghe arm from the morphologic point of view and its fragile longitudinal and lateral connectivity through morphometric analysis methods with the help of GIS and remote sensing techniques. The foundation of this study was based on

existing literature, historical and current field data. In addition, this research facilitates the assessment of the new conditions of sedimentary transfer in the lower area of the Danube and the impact on the morphological course of the Sfântu Gheorghe arm.

During the doctoral studies, field data was collected to evaluate the degree of evolution and trends of the riverbed on the main course of the Sfântu Gheorghe arm and its meanders. Historical and current bathymetric data were used to determine the morphodynamic evolution of the submerged relief. At the same time, remote sensing techniques were used with the help of satellite and aerial images in order to extract information about the configuration of islands and shores necessary for the quantification of sedimentation and erosion processes by highlighting the emerged and submerged surface areas.

The main purpose of this doctoral thesis is the updating of hydrological information and the analysis of the hydromorphological evolution of the Sfântu Gheorghe arm on its meandering sectors and on its rectification channels. The reference information is presented in the literature which dates from the 1990s for the orthophoto images, and 1994 considering the hydrological data. These data have been translated into digital format and updated with those from more recent measurements and those collected during doctoral studies.

The thesis details the data collection activity from the field and the methodologies used in order to aggregate the information found in the literature, its digitization and harmonization with the new data from recent measurements. Therefore, there is description regarding the steps taken in order to determine the altimetric landmarks related to the shores in the studied areas. Later, the activity of bathymetric measurements with a multibeam sonar and also with an Acoustic Doppler Current Profiler (ADCP) equipment is detailed in order to determine water flows and velocities on the profile water column. At the same time, there is description regarding the methods of processing bathymetric data, flows and velocities, for which maps are developed. Next, description of the methodology for characterizing meander curves according to the Bagnold 1960 standard – which is the characterization that provides comparative results with data from the literature in the form of evolutionary indicators. Finally, information is provided on the publication of bathymetric data in the European EMODnet project database.

In the analytical part of the thesis, all the analyzed information is concatenated to allow a holistic approach in order to determine some correlations between the morphometric parameters of the emerged and submerged surfaces. Comparisons are made between all the studied meanders to determine an evolutionary pattern, taking into account the rectifications brought to the Sulina arm.

The analysis is structured in 4 main segments, each representing a meander or a group of meanders: the Mahmudia meander between kilometers 84 and 64, the Dunavaț and Perivolovca meander group between kilometers 58 and 49, the Dranov and Erenciuc meander group between kilometers 44 and 29 and the Ivancea meander between kilometers 20 and 16. Each of these segments deals with 3 main aspects, namely: geomorphology and structure over time series, which also includes the geometric characterization of the meander curves, the distribution of liquid flows and changes in the sections of the river bed. The data is presented in detail in tabular form, charts and maps.

The morphodynamic analyze of the banks of the Sfântu Gheorghe arm were carried out through comparative studies on data sets from aerial photogrammetry (1990, 2004, 2011 and present day). These analyzes were carried out through typical GIS processes that required the digitization and georeferencing of the images from archives for the reference year 1990. The results include maps and tabular information regarding the erosion and sedimentation processes for each meandering sector analyzed by quantifying the emerged and submerged surfaces.

In order to appreciate the degree of morphodynamic balance but also to characterize and frame the typologies of the studied meander curves, the ratio between the wavelengths of the meanders and the width of the water body (r_m/d) was calculated according to the R. A. Bagnold 1960 methodology. Considering the previous morphodynamic analyzes, these characterizations of the meanders were made through geometric determinations using GIS applications. The aim of these analyzes determine two main assessments, namely (i) the characterization and framing of meander curve typologies as indicators of connectivity to the main course of the arm, according to the standard deviation of values from Bagnold's methodology, and (ii) determination of correlations of the indicator values with other morphometric parameters.

The analysis of the evolution of the river bed related to the meandering sectors of the Sfântu Gheorghe arm was carried out through comparative studies of the historical and current bathymetric sections. The bathymetric changes and the distribution of water flows was done and analyzed by capitalizing on the information found in the literature and the determinations in the field through bathymetric measurements with single beam and multi beam sonars respectively with the doppler technique.

The study continued to determine and research the possibility of correlating certain morphometric values of the meanders, highlighted by the regression coefficients and their degree of confidence. Based on all the results of the analyzes, discussions, maps and available publications, hypotheses are proposed concerning the evolution of these meanders and groups of meanders.

According to the work carried out in this study, it can be said that each meander has its characteristic evolution, with typical morphohydrological particularities presenting, more or less, similarities in their morphodynamic evolution. However, each meander has a particular hydrosedimentary evolution and the general picture indicates the same outcome as in the case of the analyzes in the existing publications: the sedimentation of the meanders and the migration of the main course towards the rectification channels.